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ABSTRACT

Faculty members in departments of chemistry, computer science, and education were surveyed to collect information on the content representativeness of the Graduate Record Examination (GRE) Advanced Tests in those disciplines. Faculty respondents allocated percentages to each of the major content categories of the specifications for the tests to reflect the nature of undergraduate curricula appropriate for prospective graduate students. They also classified test items into those same categories. This study compared the distribution of content specified by the Committees of Examiners, the distribution of content produced by the respondents, and the distribution of test items by content categories as classified by the respondents. Agreement was generally good, although some differences emerged that might suggest minor changes in specifications or item composition. The method is documented in some detail (Appendix E) so that it can be applied periodically to other tests when desired. The information gathered by the method can be of value to the Committees of Examiners in keeping the tests abreast of trends and changes in their fields. (Author)

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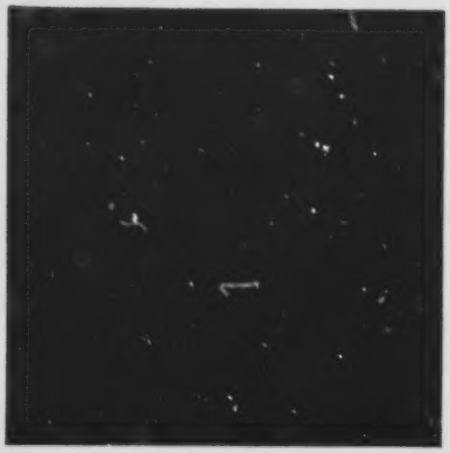

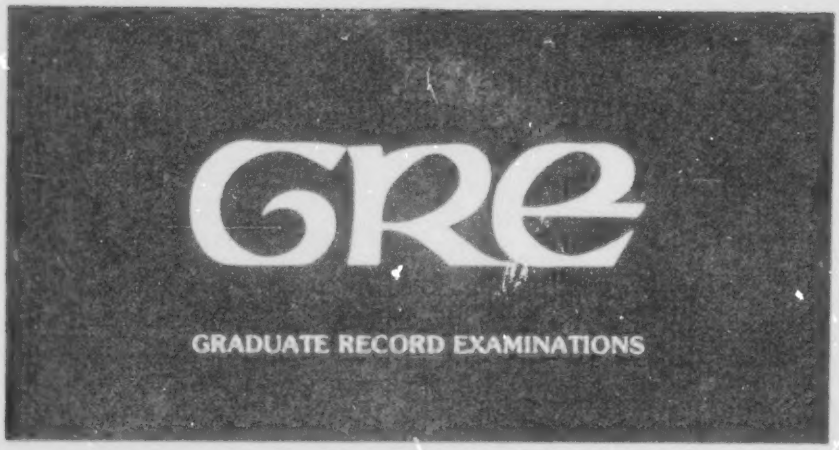

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CONTENT REPRESENTATIVENESS OF THE GRADUATE RECORD EXAMINATIONS ADVANCED TESTS IN CHEMISTRY, COMPUTER SCIENCE, AND EDUCATION

Philip K. Oltman

GRE Board Professional Report GREB No. 81-12P

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December 1982

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EDUCATIONAL TESTING SERVICE, PRINCETON, NJ

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Content Representativeness of the Graduate Record Examinations Advanced Tests in Chemistry, Computer Science, and Education

Philip K. Oltman

GRE Board Professional Report GREB No. 81-12P

December 1982

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Abstract

Faculty members in departments of chemistry, computer science, and education were surveyed to collect information on the content representativeness of the GRE Advanced Tests in those disciplines. Faculty respondents allocated percentages to each of the major content categories of the specifications for the tests to reflect the nature of undergraduate curricula appropriate for prospective graduate students. They also classified test items into those same categories. We compared the distribution of content specified by the Committees of Examiners, the distribution of content produced by the respondents, and the distribution of test items by content categories as classifed by the respondents. Agreement was generally good, although some differences emerged that might suggest minor changes in specifications or item composition. The method is documented in some detail so that it can be applied periodically to other tests when desired. The information gathered by the method can be of value to the Committees of Examiners in keeping the tests abreast of trends and changes in their fields.

Content Representativeness of the Graduate Record Examinations Advanced Tests in Chemistry, Computer Science, and Education

The content and scope of the GRE Advanced Tests are determined by Committees of Examiners appointed by ETS. The aim of each Committee is to include in the test the knowledge, understanding, and abilities basic to and most important for successful graduate study in the discipline being assessed. Keeping the tests abreast of trends and changes in the fields is an important consideration. To provide additional input to the Committees' work in developing the tests, the GRE Board has funded studies aimed at sampling the views of faculty members at large on the representativeness of the content coverage of the Advanced Tests. The present report describes the most recent of these studies.

Content representativeness depends primarily on the adequacy with which a specified domain of content is sampled. In the present context, the sampling is intended to draw upon content that is basic to and most important for success in graduate study. The Committees of Examiners compose specifications for the tests and, with the assistance of other qualified subject-matter specialists, write items to fit those specifications so the distribution of item content reflects the distribution of content set forth in the specifications. The GRE Board has determined that the Committees might be assisted in their work by obtaining the views of a larger group of subject-matter specialists, viz., faculty members who are currently teaching in the areas in question. The present study provides a summary of the judgments of faculty members about some of the results of these test development efforts. In particular, we have collected judgments by faculty members of the content coverage provided by their curricula and by the test items themselves. With these data, we can compare the respondents' recommendations for distribution of content with what they actually judge the test items to cover and with what the Committees have set forth in their specifications.

Respondents were asked to indicate, for each major category of subject-matter content in the specifications, what percentage of their own current undergraduate curriculum dealt with that category. Second, they were asked to imagine an ideal curriculum and to note what percentage of such a curriculum would deal with each category of subject matter. Third, they were asked to examine a current Advanced Test in their field and to indicate the category of subject matter associated with each item in the test. The item classifications were then totaled and converted to percentages so that comparisons could be made between the perceived content of the test, the perceived content of the actual and ideal curricula, and the test specifications. These comparisons were intended to provide information to the Committees that would prove useful in their test development efforts.

Test construction begins with a type of stratified sampling, in which the domain is divided into strata according to conceptual criteria, and these strata are then assigned weights to reflect the relative importance placed on the different categories of the specification set. For the present purpose, we focused on these weights as a way to evaluate the extent to which faculty members in particular disciplines agreed with the

Committees' weighting of the sections of the specifications. For example, if the Committee specified that 40 percent of the test content should deal with Category C of the specifications, while the average faculty member felt that about 30 percent of the test should deal with that content, the Committee might wish to consider adjusting the content distribution in the test to more closely reflect the judgment of those faculty members.

Similarly, with respect to the items in the test, the Committees have classified the items according to the categories in the specifications that they address. The distribution of items is tailored to match the distribution set forth in the specifications. A group of faculty members may also classify the items into categories, and the resulting distributions may be compared to the specifications set forth by the Committee and to those recommended by the faculty members. Discrepancies in item distribution thereby revealed might be adjusted by the Committee for future forms of the test, if they feel that the divergence is sufficient to justify such a step.

Three disciplines, chemistry, computer science, and education, were chosen for the present study. Both high volume and diversity of content were considerations in making these choices. Our intention was to devise a straightforward method for conducting such surveys that could be applied periodically to any of the Advanced Tests. Therefore the present report describes both the results for these disciplines and the general method.

Method

Appendix E sets forth in considerable detail the method used in conducting the present study. It is written in the form of a general manual that can be applied periodically to any of the Advanced Tests as desired. At this point in the report, we will describe the method in summary form, with details being reserved for the appendix.

We note here that all materials sent, including letters to department chairpersons, respondents, and other study materials, were initially reviewed by the members of the Committees of Examiners and by the ETS test specialists. A number of valuable suggestions from those reviewers were incorporated in the final versions of these materials.

Institutions

The original samples of institutions were drawn via a stratified random sampling procedure from the data tapes of the Higher Education General Information Survey (HEGIS). The samples were drawn for each discipline independently. We attempted to draw between 8 and 10 institutions in each of the eight HEGIS geographical regions, subject to the following stratifications:

Control: approximately 50 percent public, 50 percent private.

Level: approximately 75 percent offer doctoral degree, 25 percent offer at least baccalaureate but not including doctorate in the discipline being surveyed.

Size: approximately 50 percent have more than 10,000 total enrollment, 50 percent have between 1,000 and 9,999 enrollment.

The sampling procedure produced a list of 69 institutions for chemistry, 64 for computer science, and 67 for education, fairly evenly distributed among geographical regions. The states included in each of the regions and lists of the institutions making up the original sample are shown in Appendix A. The procedure is documented in detail in Appendix F.

Chairperson Contacts

Letters were sent to the chairperson of each department drawn in the samples, inviting participation in the study and requesting the names of two faculty members of each department to serve as respondents. A sample letter is shown in Appendix B.

Respondent Mailing

A covering letter introducing the study and the study materials were mailed to each respondent designated by the chairpersons who indicated positive response. The respondent letters and a specimen set of materials are shown in Appendix C. Since this mailing included a current form of the tests, the mailing was carried out through Test Files. Complete sets of materials were supplied to Test Files, and their staff then attached the test forms (Form DGR in each case) and mailed the set of materials to respondents, using their standard procedures. Upon completion of the tasks, respondents mailed the materials back to Test Files. Project staff then picked up the received materials and coded and processed the data.

Each respondent received the following materials:

1. Respondent Letter. A covering letter introducing the study.
2. Background Information Questionnaire. A form eliciting information about each respondent to characterize the sample (academic rank, years of teaching experience, teaching load, etc.).
3. Introduction to the Specifications. A request that respondents read and review the specifications for the test.

4. Detailed Specifications. Specifications for the current test, in outline form, deleting percentage coverage information.

5. Introduction to Specification Distribution. Instructions to respondents requesting that they assign percentages of coverage to each of the major content categories to reflect both their current undergraduate curriculum for graduate-school-bound students and an "ideal" undergraduate curriculum for such students.

6. Specification Distribution Sheet. A form on which the respondent indicated the requested percentages.

7. Special Specification Distribution (for chemistry only). Chemists were asked to go back to the section of the specifications that pertained to their own specialty and assign percentages to each of the subcategories within it, according to the "ideal" undergraduate curriculum criterion.

8. Introduction to Item Classification. Contains instructions for classifying a designated subset of the items into the categories of content in the specifications. The sets of items so classified by respondents in each discipline were as follows:

Chemistry: Chemists classified the subset of the total of 150 items in the test that were marked by the ETS test specialist as falling within their specialty. The number of items per specialty were:

Analytical Chemistry: 25 items
Inorganic Chemistry: 35 items
Organic Chemistry: 45 items
Physical Chemistry: 45 items

Computer Science: Of the 80 items in the test, respondents were asked to classify either the first 40 or the second 40.

Education: Of the 200 items in the test, respondents were asked to classify either the first, second, third, or fourth group of 50 items.

Note that for each discipline respondents were allowed to classify items into more than one content category if they so wished.

9. Test Form 3DGR. This current form of the test was premarked to indicate to respondents which subset of items they were to classify.

Results

Description of Respondent Sample

Response rates were quite similar across the three disciplines. Letters inviting participation were sent to department chairpersons (chemistry, 69; computer science, 64; education, 67). We received positive responses from 59 percent of the chemistry departments, 59 percent of the computer science departments, and 61 percent of the education departments. The others either declined to participate or did not reply, either to the initial mailing or to a follow-up mailing. (Some attempts were made at telephone follow-up, but these were discontinued because of the difficulty of contacting the appropriate individuals.) Upon receipt of a positive response, which included names of respondents, the materials were sent out by Test Files to those individuals (84 to chemistry respondents, 77 to computer science respondents, and 73 to education respondents). The respondent samples included in this report consist of 60 chemistry respondents (71 percent of the mailing), 54 computer science respondents (70 percent of the mailing), and 56 education respondents (77 percent of the mailing).

Institutions with at least one respondent included in the samples are indicated with an asterisk in Appendix A. The composition of the sample of respondents' institutions is shown in Table 1, based on control (public vs. private), level (nondoctoral vs. doctoral), and size of institution (greater or less than 10,000 total enrollment). Individual descriptive data for each respondent sample are shown in Table 2.

Chemistry

In the case of chemistry, the ETS test specialist's view was that respondents should allocate content and classify items in their own areas of specialization rather than for the discipline as a whole. We did ask respondents to allocate content to the four main areas, viz., analytical, inorganic, organic, and physical chemistry. However, following that step, respondents were asked to allocate content to an ideal curriculum within their own areas of specialization and to classify items within those areas. The test specialist provided the major fields by means of a professional directory and then marked each item in the test for a given respondent that fell into his or her specialty.

Allocation of content to the four major fields. A total of 59 respondents completed this task. The means are shown in Table 3. Respondents' allocations of percentages to reflect their current curriculum and an ideal curriculum agreed closely. Allocations were not affected

Table 1

Chemistry

Frequency of Respondents Classified by

Type of Institution

Size	Level	Control		Total
		Public	Private	
Small	Nondoctoral	8	3	11
	Doctoral	10	9	19
	Total	18	12	30
Large	Nondoctoral	6	5	11
	Doctoral	16	3	19
	Total	22	8	30

Total observed frequency is 60.

Table 1

Computer Science

Frequency of Respondents Classified by

Type of Institution

Size	Level	Control		Total
		Public	Private	
Small	Nondoctoral	6	5	11
	Doctoral	12	5	17
	Total	18	10	28
Large	Nondoctoral	6	2	8
	Doctoral	15	3	18
	Total	21	5	26

Total observed frequency is 54.

Table 1

Education

Frequency of Respondents Classified by

Type of Institution

Size	Level	Control		Total
		Public	Private	
Small	Nondoctoral	4	4	8
	Doctoral	14	5	19
	Total	18	9	27
Large	Nondoctoral	9	0	9
	Doctoral	13	7	20
	Total	22	7	29

Total observed frequency is 56.

Table 2

Chemistry

Descriptive Data

Specialty	Analytical Chemistry	N = 9
	Inorganic Chemistry	N = 11
	Organic Chemistry	N = 24
	Physical Chemistry	N = 16
Academic Rank	Professor	N = 38
	Associate Professor	N = 15
	Assistant Professor	N = 16
	Instructor, Other	N = 1
Administrative Responsibility	Yes	N = 31
	No	N = 29
Years Teaching	$\bar{X}$ = 15.1	Range = 0 to 34
Year of Highest Degree	$\bar{X}$ = 1966	Range = 1947 to 1981
Teaching Load, Hours Per Week	$\bar{X}$ = 9.9	Range = 3 to 20
Doctoral Dissertations Directed, Past Five Years	$\bar{X}$ = 1.1	Range = 0 to 12
Masters Theses Directed, Past Five Years	$\bar{X}$ = 1.7	Range = 0 to 7
Geographical Region	New England	N = 4
	Mid East	N = 10
	Great Lakes	N = 10
	Plains	N = 5
	Southeast	N = 9
	Southwest	N = 7
	Rocky Mountains	N = 7
	Far West	N = 8

Table 2

Computer Science

Descriptive Data

Academic Rank	Professor	$\underline{N}$ = 7
	Associate Professor	$\underline{N}$ = 25
	Assistant Professor	$\underline{N}$ = 19
	Instructor, Other	$\underline{N}$ = 2
Administrative Responsibility	Yes	$\underline{N}$ = 24
	No	$\underline{N}$ = 29
Years Teaching	$\overline{X}$ = 10.1	Range = 1 to 26
Year of Highest Degree	$\overline{X}$ = 1973	Range = 1955 to 1982
Teaching Load, Hours Per Week	$\overline{X}$ = 8.6	Range = 4 to 14
Doctoral Dissertations Directed, Past Five Years	$\overline{X}$ = 0.5	Range = 0 to 8
Master's Theses Directed, Past Five Years	$\overline{X}$ = 2.3	Range = 0 to 30
Geographical Region	New England	$\underline{N}$ = 3
	Mid East	$\underline{N}$ = 9
	Great Lakes	$\underline{N}$ = 5
	Plains	$\underline{N}$ = 11
	Southeast	$\underline{N}$ = 4
	Southwest	$\underline{N}$ = 13
	Rocky Mountains	$\underline{N}$ = 5
	Far West	$\underline{N}$ = 4

Table 2

Education

Descriptive Data

Academic Rank	Professor	$\underline{N}$ = 26
	Associate Professor	$\underline{N}$ = 20
	Assistant Professor	$\underline{N}$ = 10
	Instructor, Other	$\underline{N}$ = 0
Administrative Responsibility	Yes	$\underline{N}$ = 30
	No	$\underline{N}$ = 26
Years Teaching	$\overline{X}$ = 13.8	Range = 2 to 30
Year of Highest Degree	$\overline{X}$ = 1970	Range = 1951 to 1981
Teaching Load, Hours Per Week	$\overline{X}$ = 10.1	Range = 0 to 30
Doctoral Dissertations Directed, Past Five Years	$\overline{X}$ = 2.1	Range = 0 to 12
Masters Theses Directed, Past Five Years	$\overline{X}$ = 8.8	Range = 0 to 60
Geographical Region	New England	$\underline{N}$ = 6
	Mid East	$\underline{N}$ = 2
	Great Lakes	$\underline{N}$ = 5
	Plains	$\underline{N}$ = 6
	Southeast	$\underline{N}$ = 16
	Southwest	$\underline{N}$ = 7
	Rocky Mountains	$\underline{N}$ = 8
	Far West	$\underline{N}$ = 6

Table 3

Chemistry, All Fields

Percents Allocated to Content Categories

	Respondents' Current Curriculum	Respondents' Ideal Curriculum	Committee Specifications
Analytical Chemistry	22.3*	22.5*	15
Inorganic Chemistry	20.3*	22.1*	25
Organic Chemistry	30.7	28.2*	30
Physical Chemistry	26.6*	27.0*	30

*Differs from Committee Specifications, $p<.0$

by control, level, or size of institution. Respondents' allocations differed somewhat from the Committee's specifications, with respondents recommending more emphasis on analytical chemistry and somewhat less on inorganic and physical chemistry than the Committee had specified. The largest divergence between respondents and the Committee was in the analytical area.

Items were not classified into the four major areas because the test specialist felt that the data produced would be of little value. Item classification data within specialties are presented below.

Content and item allocation within specialties. The nine analytical chemists showed close agreement between their allocation of content to reflect an ideal curriculum and their classification of items into the two categories of content in this area (Table 4). For these and the following analyses, Committee allocations are not available, because the coverage below the four major subfields is not quantified. A more detailed breakdown of mean percentages assigned to topics within the two categories is presented in Appendix D.

The 11 inorganic chemists' content and item allocations are shown in Table 5. They recommended more coverage of atomic theory and less coverage of extranuclear structures and related properties than they observed in the test items. A more detailed table presenting means for topics within the four categories is shown in Appendix D.

The 24 organic chemists recommended more coverage of principal reactions of simple functional groups and less of structure and mechanism, as indicated by the differences between their ideal curriculum allocations and their item classifications for these topics (Table 6). A detailed table of means for the topics within the three categories is presented in Appendix D.

Finally, the 16 physical chemists showed close agreement between an ideal curriculum and item coverage for the three categories of their specialty (Table 7). A detailed table of means for topics within the categories is presented in Appendix D.

Summary. Relative to the Committee specifications, the total group of respondents recommended more coverage of analytical chemistry at the expense of inorganic and physical chemistry. Analytical and physical chemists saw good agreement between their recommendations for coverage and the percentages of items in the categories. Inorganic chemists saw more extranuclear structure items and fewer atomic theory items than they recommended, and organic chemists saw more structure and mechanism and fewer principal reactions items than they recommended.

The detailed tables in Appendix D may be helpful to the Committee in further specifying the particular types of items responsible for the few divergencies that were found between content recommendations and item classifications.

Table 4

Analytical Chemistry

Percents Allocated to Content Categories

	Respondents' Ideal Curriculum	Respondents' Item Classification
Classical Quantitative Area	50.6	57.6
Instrumentation Area	49.4	42.4

Table 5

Inorganic Chemistry

Percents Allocated to Content Categories

	Respondents' Ideal Curriculum	Respondents' Item Classification
Atomic Theory	13.3*	5.3
The Nucleus	7.6	8.0
Extranuclear Structures and Related Properties	29.1*	40.5
Chemistry of the Families of Elements	50.0	46.7

*Differs from Respondents' Item Classification, $p<.05$.

Table 6

Organic Chemistry

Percents Allocated to Content Categories

	Respondents' Ideal Curriculum	Respondents' Item Classification
Principal Reactions of Simple Functional Groups	45.8*	36.6
Structure and Mechanism	32.7*	40.1
More Advanced Topics and Special Topics	21.5	23.3

*Differs from Respondents' Item Classification, $p<.05$.

Table 7

Physical Chemistry

Percents Allocated to Content Categories

	Respondents' Ideal Curriculum	Respondents' Item Classification
Chemical and Statistical Thermodynamics	37.9	40.4
Quantum Chemistry and Spectroscopy	30.9	31.2
Kinetics and Other Topics	31.1	28.4

Computer Science

The mean percents allocated by respondents to each of the five major subdivisions of the subject-matter domain are shown in Table 8. A total of 53 respondents indicated their allocations to represent their current curriculum and an ideal curriculum, and 54 respondents classified items into the five subdivisions. A total of 26 respondents classified the first 40 items and 28 classified the second 40 items of the 80-item test.

For software systems and methodology, the allocations to the Ideal curriculum and item classifications agreed with each other and with the Committee specifications. Apparently, however, the respondents felt that their own current curriculum overemphasized this area.

For computer organization and logic, there was good agreement among curricula, items, and specifications. Theory allocations indicated that respondents felt that their current curricula had less stress on theory than would be ideal. The item classification percentage did not differ substantially from the Committee specification for theory. Respondents saw more computational mathematics items in the test than their curriculum allocations and more such items than the Committee specifications call for. Respondents allocated more of the curriculum to special topics than are called for by the Committee specifications and classified fewer items in that category than the Committee specified.

Neither current nor ideal percent allocations were related to the public-private distinction, the highest degree given, or the size of institution.

Summary. Respondents seemed to feel that their own current curriculum had more emphasis on software systems and methodology than was reflected in the items or specifications. Their current and ideal curricula had less emphasis on theory than did the test or the Committee specifications. They also found that the test contained more computational mathematics items than either they or the Committee specified. Finally, there appeared to be a desire for more items dealing with special topics.

Education

A total of 56 faculty members participated; 54 respondents allocated current percentages to the five areas, 55 allocated ideal percentages to the areas, and 56 classified items.

Groups of 15 classified the first, second, and third set of 50 items, and 11 respondents classified the fourth set of 50 items from the 200-item test. The mean percentages allocated are shown in Table 9.

Good agreement between curricula and Committee specifications was found for educational goals, although respondents classified more items in that category than the Committee specified. For administration and supervision of the schools, the number of items was seen to match the

Table 8

Computer Science

Percents Allocated to Content Categories

	Respondents' Current Curriculum	Respondents Ideal Curriculum	Respondents' Item Classification	Committee Specifications
Software Systems and Methodology	40.7*	33.1	33.0	35
Computer Organization and Logic	20.1	20.7	20.1	20
Theory	12.2*	17.7*	20.5	20
Computational Mathematics	15.5*	16.6*	23.4*	20
Special Topics	11.5*	11.9*	2.7*	5

*Differs from Committee Specifications, $p<.05$.

Table 9

Education

Percents Allocated to Content Categories

	Respondents' Current Curriculum	Respondents' Ideal Curriculum	Respondents' Item Classification	Committee Specifications
Educational Goals	15.9	16.4	17.8*	15
Administration and Supervision of the Schools	11.1*	12.3*	15.8	15
Curriculum Development and Organization	24.4*	21.1*	13.6	15
Teaching-Learning	35.4*	32.6*	33.0*	40
Measurement, Evaluation, and Research	13.4*	17.0*	19.9*	15

*Differs from Committee Specifications, $p<.05$.

Committee specifications, but both were high relative to what respondents were teaching or would teach in ideal curricula. The opposite pattern appeared for curriculum development and organization; both current and ideal allocations were higher than either the Committee specifications or the number of items classified into this category. For teaching-learning, the Committee apparently specified more content than was judged to appear in the items or than was allocated to the curricula by respondents. Finally, for measurement and evaluation, the percent of items classified into this category was higher than the Committee specifications; while current curriculum was lower than the Committee specifications, ideal curriculum was higher.

With one borderline exception, control, level, and size of institution were unrelated to the allocation of percentages to areas. The exception was the difference between programs with no doctorate and those with a doctoral program in the area of teaching-learning: The 17 nondoctoral program respondents recommended 30.9 percent here, while the 37 doctoral program respondents recommended 37.5 percent to represent their current programs (a significant difference, $p < .05$)

Summary. According to the respondents, the items and Committee specifications overrepresent administration and supervision of the schools, and underrepresent curriculum development and organization. The Committee specifications for teaching-learning appeared high, but the percentage of items closely matched both current and ideal curricula. This pattern suggests that the test composition is judged satisfactory in this area, but that the Committee specifications are higher than the test actually reflects. Respondents apparently felt that their own curricula should contain somewhat more material on measurement, evaluation, and research; the Committee specification percents are higher than the percents in current curriculum, but lower than either the ideal curriculum or the judged item content.

Discussion

While several discrepancies appeared between Committee specifications, judged item content, and respondents' allocation of content, none were dramatic. The Committees must judge whether the observed discrepancies are of enough practical significance to warrant "fine tuning" of the specifications and test content to more closely match respondents' judgments. In any case, the results can serve as a guide in future test revisions and for new item writing. The overall impression we gained from the data is that the tests and specifications show good agreement with what faculty members in the respective disciplines think is being taught and with what they think should be taught.

The procedures used in the study, which are described in more detail in the manual (Appendix E), are straightforward and readily adaptable for specific needs. Periodic application of these procedures can provide useful information to the Committees to check the content representativeness of current tests and to guide revisions for future forms.

We have used two different approaches in gathering the data for this report. With computer science and education, respondents allocated percentages to the main categories of the specifications and classified an arbitrary subset of items into those same categories. With chemistry, we followed the test specialist's advice and requested percentage allocations within a given respondent's own field of specialization (analytical, inorganic, organic, or physical chemistry). Also, item classifications were limited to those items in the respondents' specialty. Either approach seemed to work well, and ETS test specialists and Committee members can best make the decision about which one would be most informative for their particular discipline. We hope that the methods we have used have struck a balance between furnishing useful information to the Committees and showing due consideration for faculty respondents.

Acknowledgment. For advice and assistance at many points in this project, we wish to thank Patricia W. Cox, Richard DeVore, Jeanne M. Finelli, Frank J. Fornoff, Raymond E. Thompson, Jefferson Wadkins, Jr., Dale C. Whittington, and Anna Mary Klein and the staff of Test Files.

Appendix A

Chemistry

Sample as Drawn from Higher Education
General Information Survey (HEGIS)

(*: Participating Institutions)

Region 1, New England
(CT, ME, MA, NH, RI, VT)

WORCESTER STATE COLLEGE
*CENTRAL CONN ST COLLEGE
*UNIVERSITY OF LOWELL
U OF RHODE ISLAND
*COLBY COLLEGE
SMITH COLLEGE
HARVARD UNIVERSITY

Region 2, Mid East
(DE, DC, MD, NJ, NY, PA)

DELAWARE STATE COLLEGE
*CUNY HUNTER COLLEGE
*CUNY GRAD SCH & U CENTER
*MORGAN STATE UNIVERSITY
RUTGERS U NEWARK CAMPUS
U OF PITTSBG MAIN CAMPUS
*MANHATTAN COLLEGE
*ROCHESTER INST TECHNOLOG
*ALFRED UNIVERSITY
GEORGE WASH UNIVERSITY

Region 3, Great Lakes
(IL, IN, MI, OH, WI)

*INDIANA U NORTHWEST
NTHESTN ILL UNIVERSITY
*MICHIGAN TECHNOLOGICAL U
*U OF AKRON MAIN CAMPUS
*U OF WISCONSIN MADISON
CARROLL COLLEGE
*UNIVERSITY OF DAYTON
*MARQUETTE UNIVERSITY

Region 4, Plains
(IA, KS, MN, MO, NE, ND, SD)

*STHEST MO ST UNIVERSITY
SAINT CLOUD ST UNIVERSIT
*U OF MISSOURI-ROLLA
SD STATE UNIVERSITY
*U OF MISSOURI-SAINT LOUI
UNIVERSITY OF IOWA
PARK COLLEGE
*DRAKE UNIVERSITY
WASHINGTON UNIVERSITY

Region 5, Southeast
(AL, AR, FL, GA, KY, LA,
MS, NC, SC, TN, VA, WV)

*FORT VALLEY STATE COLLEG
FLORIDA TECHNOLOGICAL U
*NORTHEAST LOUISIANA U
U ALABAMA IN HUNTSVILLE
VIRGINIA COMMONWEALTH U
*MIDDLE TENN ST UNIVERSIT
*LYNCHBURG COLLEGE
*BOB JONES UNIVERSITY
UNIVERSITY OF MIAMI

Region 6, Southwest
(AZ, NM, OK, TX)

*SUL ROSS STATE UNIVERSIT
*CENTRAL STATE UNIVERSITY
EAST TEXAS ST UNIVERSITY
NM INST OF MINING & TECH
*STEPHEN F AUSTIN STATE U
*SAM HOUSTON ST UNIVERSIT
BISHOP COLLEGE
UNIVERSITY OF TULSA

Region 7, Rocky Mountains
(CO, ID, MT, UT, WY)

U OF COLO COLO SPRINGS
*METROPOLITAN ST COLLEGE
*UNIVERSITY OF IDAHO
UNIVERSITY OF MONTANA
U OF COLORADO AT BOULDER
U OF NORTHERN COLORADO
WESTMINSTER COLLEGE
*BRIGHAM YOUNG U MAIN CAM
*UNIVERSITY OF DENVER

Region 8, Far West
(AK, CA, HI, NV, OR, WA)

*CAL STATE U-DOMINGUEZ HL
*CAL STATE U-SACRAMENTO
U OF CAL-IRVINE
U OF NEVADA RENO
PORTLAND STATE UNIVERSIT
*CAL STATE U-LOS ANGELES
LINFIELD COLLEGE
UNIVERSITY OF LA VERNE
*STANFORD UNIVERSITY

Computer Science

Sample as Drawn from Higher Education
General Information Survey (HEGIS)

(*: Participating Institutions)

Region 1, New England
(CT, ME, MA, NH, RI, VT)

*FRAMINGHAM STATE COLLEGE
CENTRAL CONN ST COLLEGE
*U OF MASS AMHERST CAMPUS
U VT & STATE AGRL COLLEG
TRINITY COLLEGE
MASS INST OF TECHNOLOGY
BOSTON UNIVERSITY

Region 2, Mid East
(DE, DC, MD, NJ, NY, PA)

*SUNY COLLEGE PLATTSBURGH
*SUNY COLLEGE AT BROCKPOR
NJ INSTITUTE TECHNOLOGY
*INDIANA U OF PENNSYLVANI
*UNIVERSITY OF DELAWARE
LOYOLA COLLEGE
NY INST TECHN MAIN CAMPU
*JOHNS HOPKINS UNIVERSITY
HOFSTRA UNIVERSITY

Region 3, Great Lakes
(IL, IN, MI, OH, WI)

*U OF WISCONSIN LA CROSSE
*U OF WISCONSIN EAU CLAIR
MICHIGAN TECHNOLOGICAL U
*INDIANA U BLOOMINGTON
CLEVELAND ST UNIVERSITY
BRADLEY UNIVERSITY
UNIVERSITY OF DETROIT
NORTHWESTERN UNIVERSITY

Region 4, Plains
(IA, KS, MN, MO, NE, ND, SD)

*MOORHEAD STATE UNIVERSIT
MANKATO STATE UNIVERSITY
*U OF ND MAIN CAMPUS
*U OF MISSOURI-ROLLA
*U OF NEBRASKA-LINCOLN
U OF KANSAS MAIN CAMPUS
*WARTBURG COLLEGE
DRAKE UNIVERSITY
*WASHINGTON UNIVERSITY

Region 5, Southeast
(AL, AR, FL, GA, KY, LA,
MS, NC, SC, TN, VA, WV)

U OF WEST FLORIDA
WESTERN KY UNIVERSITY
*FLA ATLANTIC UNIVERSITY
C OF WILLIAM AND MARY
UNIVERSITY OF LOUISVILLE
U OF ARKANSAS MAIN CAMPU
MORRIS BROWN COLLEGE
*EMORY UNIVERSITY
*UNIVERSITY OF MIAMI

Region 6, Southwest
(AZ, NM, OK, TX)

U HOUSTON CLEAR LAKE CIT
*CENTRAL STATE UNIVERSITY
*EAST TEXAS ST UNIVERSITY
*NM INST OF MINING & TECH
*U OF NM MAIN CAMPUS
*U OF TEXAS AT AUSTIN
*ORAL ROBERTS UNIVERSITY
*BAYLOR UNIVERSITY

Region 7, Rocky Mountains
(CO, ID, MT, UT, WY)

METROPOLITAN ST COLLEGE
*UTAH STATE UNIVERSITY
*UNIVERSITY OF MONTANA
UNIVERSITY OF UTAH
COLORADO STATE UNIVERSIT
*WESTMINSTER COLLEGE
*BRIGHAM YOUNG U MAIN CAM

Region 8. Far West
(AK, CA, HI, NV, OR, WA)

U ALAS ANCHORAGE CAMPUS
CAL STATE U-FULLERTON
U OF CAL-IRVINE
*U OF CAL-LOS ANGELES
*U OF OREGON MAIN CAMPUS
*PACIFIC UNION COLLEGE
LOMA LINDA UNIVERSITY

Education

Sample as Drawn from Higher Education
General Information Survey (HEGIS)

(*: Participating Institutions)

Region 1, New England
(CT, ME, MA, NH, RI, VT)

FITCHBURG STATE COLLEGE
*SOUTHERN CONN ST COLLEGE
*UNIVERSITY OF LOWELL
U OF MASS AMHERST CAMPUS
SUFFOLK UNIVERSITY
SMITH COLLEGE
*BOSTON COLLEGE

Region 2, Mid East
(DE, DC, MD, NJ, NY, PA)

SUNY EMPIRE STATE COLLEG
TOWSON STATE UNIVERSITY
MORGAN STATE UNIVERSITY
*CUNY GRAD SCH & U CENTER
PA STATE U MAIN CAMPUS
UNIVERSITY OF DELAWARE
GANNON COLLEGE
LONG IS U C W POST CENTE
*UNIVERSITY OF ROCHESTER
ADELPHI UNIVERSITY

Region 3, Great Lakes
(IL, IN, MI, OH, WI)

*CHICAGO STATE UNIVERSITY
NTHESTN ILL UNIVERSITY
KENT STATE U MAIN CAMPUS
MIAMI UNIVERSITY MAIN CA
*DEPAUW UNIVERSITY
ASHLAND COLLEGE
*MARQUETTE UNIVERSITY

Region 4, Plains
(IA, KS, MN, MO, NE, ND, SD)

NTHEST MO ST UNIVERSITY
*MANKATO STATE UNIVERSITY
*U OF SD MAIN CAMPUS
*ND STATE U MAIN CAMPUS
WICHITA STATE UNIVERSITY
*U OF KANSAS MAIN CAMPUS
NEBR WESLEYAN UNIVERSITY
DRAKE UNIVERSITY
WASHINGTON UNIVERSITY

Region 5, Southeast
(AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, VA, WV)

*DELTA STATE UNIVERSITY
*MARSHALL UNIVERSITY
*U OF NORTH FLORIDA
TENNESSEE TECHNOLOGICAL
*LA STATE U AND A&M C
*UNIVERSITY OF LOUISVILLE
*MISSISSIPPI COLLEGE
*BOB JONES UNIVERSITY
*UNIVERSITY OF MIAMI

Region 6, Southwest
(AZ, NM, OK, TX)

TEXAS EASTERN UNIVERSITY
*STHWST TEX ST UNIVERSITY
*TEXAS WOMAN'S UNIVERSITY
TEXAS SOUTHERN UNIVERSIT
U OF HOUSTON CEN CAMPUS
*NM STATE U MAIN CAMPUS
BETHANY NAZARENE COLLEGE
*PHILLIPS UNIVERSITY

Region 7, Rocky Mountains
(CO, ID, MT, UT, WY)

*WESTERN ST COLLEGE COLO
*METROPOLITAN ST COLLEGE
*MONTANA STATE UNIVERSITY
*U OF COLO AT DENVER
COLORADO STATE UNIVERSIT
*U OF COLORADO AT BOULDER
BRIGHAM YOUNG U MAIN CAM
*UNIVERSITY OF DENVER

Region 8, Far West
(AK, CA, HI, NV, OR, WA)

CAL STATE C-SN BERNARDIN
CAL STATE POLY U-POMONA
*U OF NEVADA RENO
*U OF NEVADA LAS VEGAS
U OF OREGON MAIN CAMPUS
*OREGON STATE UNIVERSITY
PACIFIC UNION COLLEGE
US INTERNATIONAL U
STANFORD UNIVERSITY

EDUCATIONAL TESTING SERVICE PRINCETON, N.J. 08541

609-921-9000
CABLE-EDUCTESTSVC

DIVISION OF EDUCATIONAL
RESEARCH AND EVALUATION

Chair, Department of Chemistry
New Jersey University
Princeton, New Jersey 08541

Dear Department Chair:

As part of a continuing effort to ensure that the Advanced Tests of the Graduate Record Examinations (GRE) reflect what is currently being taught at colleges and universities, the GRE Board, which oversees the testing program, has authorized a study of the content representativeness of the GRE Advanced Tests. The tests are developed under the guidance of a Committee of Examiners who are specialists in various aspects of the fields and who come from undergraduate and graduate faculties representative of different types of institutions and different regions of the United States. Although the members of the committees are rotated on a regular basis, they represent, at any one time, only a limited sample of those actively engaged in the teaching of their fields. This content representativeness study is designed to provide a larger sample of professional judgments about the tests and their relation to curricula at various institutions. The study will attempt specifically to determine to what extent the tests reflect the undergraduate curricula recommended as preparation for graduate study in various fields and to verify that the questions in recent editions of the tests adequately reflect the content specifications that guide their development.

We are asking your institution for assistance by designating two representatives to participate in this content representativeness study by completing three brief questionnaires. The first will list the content categories that constitute the specifications for the development of the GRE Advanced Chemistry Test and will ask you and/or the respondents you name to assess the importance of each of these categories in your undergraduate curriculum, and to list any additional categories your institution emphasizes. To verify the relationship between the specifications and actual test questions, the second questionnaire will ask the respondents to classify some of the questions from a current test in terms of the content categories. The third questionnaire will ask for information about the respondents and your institution so that users of the study may be provided with general data concerning the sample on which the study was based. If possible, it would be helpful if the respondents represent different areas of specialization within your discipline.

If you agree to take part in the study, we ask that you send the names and addresses of the respondents whom you wish to complete the three questionnaires, using the enclosed return envelope. Shortly thereafter, the materials will be sent directly to the respondents.

We hope you and your colleagues will be able to participate in this study. The results will provide useful information concerning the relevance of the GRE Advanced Chemistry Test and will enable the Committee of Examiners to continue the process of adjusting the content of the test to reflect what is currently being taught in undergraduate curricula. Thank you.

Sincerely,

Philip K. Oltman

Philip K. Oltman, Ph.D.
Division of Educational Research
and Evaluation
609/921-9000

C

Appendix C

MEMORANDUM FOR: TEST FILES, D-420

SUBJECT: Request for Outside Loan

FROM: Philip K. Oltman

PLEASE SEND TO:

DATE:

THE FOLLOWING TESTS:

Program	Name of Test	Form	Project and Job
GRE	Chemistry	3DGR	546-78

CHECK ONE:

Registered: -----

Certified: X

THE PERIOD OF LOAN IS:

COMMITTEE COPY: _____ (Please indicate EXACT date material is to be returned.)

REGULAR OUTSIDE LOAN (Please check one):

- X 30 days (inspection copy within United States or Canada)
- _____ 90 days (inspection copy outside United States or Canada)
- _____ 6 months (for use of Test Construction Committee)
- _____ Permanent (official copy for contractor)
- _____ Other - Please specify _____

SIGNED Philip K. Oltman

If the above signature is not on Test Files' authorized list, this request cannot be filled until it is approved and signed by the Program Director whose test is to be lent.

PROGRAM DIRECTOR

EDUCATIONAL TESTING SERVICE PRINCETON, N.J. 08541

609-921-9000
CABLE-EDUCTESTSVC

DIVISION OF EDUCATIONAL
RESEARCH AND EVALUATION

Professor Joyce Doe
Department of Chemistry
New Jersey University
Princeton, New Jersey 08541

Dear Professor Doe:

You are being asked to participate in a content representativeness study of the Graduate Record Examinations Advanced Chemistry Test. Completing the enclosed questionnaires should require no more than a half hour of your time. If you wish to spend more time in examining the test and recording your reactions to it at greater length than the questionnaires permit, we would be happy to have you do so.

In case you were not the recipient of the letter that was originally sent to your department, here is an excerpt from the part of the letter that describes the study.

> As part of a continuing effort to ensure that the Advanced Tests of the Graduate Record Examination (GRE) reflect what is currently being taught at colleges and universities, the GRE Board, which oversees the testing program, has authorized a study of the content representativeness of the GRE Advanced Tests. The tests are developed under the guidance of a Committee of Examiners who are specialists in various aspects of the fields and who come from undergraduate and graduate faculties representative of different types of institutions and different regions of the United States. Although the members of the committee are rotated on a regular basis, they represent, at any one time, only a limited sample of those actively engaged in the teaching of their fields. This content representativeness study is designed to provide a larger sample of professional judgments about the tests and their relation to curricula at various institutions. The study will attempt specifically to determine to what extent the tests reflect the undergraduate curricula recommended as preparation for graduate study in the various fields and to verify that the questions in recent editions of the tests adequately reflect the content specifications that guide their development.

The three different questionnaires enclosed ask you to do the following:

I. [illegible]icate the material that is covered in your undergraduate chemistry curriculum.

II. Check of the content classification of a designated set of questions (about 50) from a recent form of the examination.

III. Provide some background information concerning you and your institution.

Because of the confidential nature of the test material included in this packet, we ask that you fill out the questionnaires and return them and the test booklet to us within two weeks of receipt of the materials. Furthermore, we ask that you not make copies of the test and that you not show it to others unless you telephone me to request authorization to do so.

We appreciate your cooperation in this study. If you have any questions, feel free to call me collect at the number shown.

Sincerely,

Philip K. Oltman

Philip K. Oltman, Ph.D.
Division of Educational Research
and Evaluation
609/921-9000

BACKGROUND INFORMATION QUESTIONNAIRE

GRE CONTENT REPRESENTATIVENESS STUDY

1. Name _____

2. Academic rank (e.g., Associate Professor) _____

3. Administrative responsibilities, if any (e.g., Department Chair, Graduate Administrator) _____

4. Official name of your department _____

5. Institution _____

6. Your speciality or area of primary interest. Make up to three entries in order of importance.

   1. _____

   2. _____

   3. _____

7. Years of teaching experience at the college level. _____

8. Year in which you received your highest earned degree. _____

9. Your average teaching load (number of contact hours per week) during the past five years (or since you started teaching if you have been teaching fewer than five years). _____

10. Approximate number of doctoral dissertations you have directed during the past five years, if any. _____

11. Approximate number of masters theses directed during the past five years, if any. _____

GRE Advanced Tests

On the following pages you will find the content specifications which are intended to guide the writing of questions for the test in your field. Please read over the detailed outline and, if you wish, indicate which topics you feel should be eliminated from the test by making an X through the letter or number next to the topic. Space is also provided if you wish to suggest additional topics under the various headings which you feel should be included but which are not presently listed.

Feel free to concentrate your review of the detailed specifications on those areas in which you have major interests.

Detailed Specifications

GRE Advanced Chemistry Test

I. Analytical Chemistry

A. Classical quantitative area

1. Titrimetry
2. Separations, including theory and applications of chromatography as well as gravimetry
3. Data handling, including statistical tests (t, F, Q, chi-square)
4. Standards and standardization techniques
5. Additional _____

B. Instrumentation area

1. Basic electronics
2. Electrochemical methods
3. Spectroscopic methods, including mass spectroscopy and those in the electromagnetic spectrum from high-energy nuclear processes of radioactivity to nuclear magnetic resonance
4. Additional _____

II. Inorganic Chemistry

A. Atomic theory

1. Elementary particles
2. Atomic structure
3. Classical experiments
4. Additional _____

B. The nucleus

1. Binding energy
2. Abundance and stability of nuclei
3. Isotopes
4. Additional _____

C. Extranuclear structures and related properties

1. Electronic distributions in atoms
2. Periodic classifications
3. Properties dependent on extranuclear structure
4. Additional _____

D. Chemistry of the families of elements

1. Preparations, reactions, properties, and important applications of the elements and their compounds stressing family relationships and dependence on extranuclear structure
2. Families of representative elements, families of transition elements, lanthanides and actinides
3. Additional _____

III. Organic Chemistry

A. Principal reactions of simple functional groups

1. Hydrocarbons
2. Alcohols
3. Alkyl and aryl halides
4. Organometallic compounds
5. Carbonyl compounds
6. Conjugate unsaturated carbonyl compounds
7. Amines
8. Diazonium compounds
9. Acids
10. Phenols
11. Simple sulfur containing compounds
12. Additional _____

B. Structure and mechanism

1. Electronic structures
2. Isomers and stereochemistry
3. Theoretical concepts
4. Basic reaction mechanisms
5. Structural interpretation of spectral (ultraviolet, infrared, nuclear magnetic resonance) data
6. Additional _____

C. More advanced topics and special topics

1. Laboratory topics
2. Classical reaction types
3. Classical rearrangements
4. Differentiations by chemical tests
5. Special reagents
6. Bifunctional compounds
7. Polymerizations
8. Natural products
9. Comparisons of reactivity
10. Biochemically-related topics
11. Additional _____

IV. Physical Chemistry

A. Classical and statistical thermodynamics

1. Equations of state
2. First, second, and third laws
3. E(U), H, S, G, μ, C_p, C_v, phase equilibria
4. Equilibrium conditions
5. Nernst's equation
6. Elementary statistical mechanics
7. Additional _____

B. Quantum chemistry and spectroscopy

1. Energy levels and wave functions for atomic and molecular electrons, harmonic oscillators, rigid rotors, and translational motions
2. Selection rules
3. Microwave, infrared, visible, Raman, and nuclear magnetic resonance spectroscopy
4. Additional _____

C. Kinetics and other topics

1. Elementary kinetic theory of gases
2. Rate laws and mechanisms
3. Crystallography
4. Dielectric properties
5. Electrochemistry
6. Surface chemistry
7. Polymers
8. Chemistry of solutions
9. Applications to biological systems
10. Additional _____

Content Representativeness of the GRE Advanced Tests

The previous pages provided a detailed description of the content categories currently included in the GRE Advanced Test in your field. On the next page, the main category headings from that outline are listed. Please read through the list and then make two judgments:

1. On a test consisting of 100 questions, how many questions should be devoted to each of the main content categories if the test were to properly represent the undergraduate curriculum for graduate-school-bound students in your discipline as it currently exists at your institution?
2. On a test consisting of 100 questions, how many questions should be devoted to each of the main content categories if the test were to properly represent an "ideal" undergraduate preparation for graduate study to your discipline? [These may or may not differ from the numbers assigned in 1.]

Note that the number of questions should add to 100 for each type of judgment.

Number of Questions in Each Content Category

GRE Advanced Test in Chemistry

Content Categories	Please Fill in Numbers of Questions to Reflect Your Current Undergraduate Curriculum for Graduate-School-bound Students	Please Fill in Numbers of Questions to Reflect an "Ideal" Preparation for Graduate Study
I. Analytical Chemistry	[ ]	[ ]
II. Inorganic Chemistry	[ ]	[ ]
III. Organic Chemistry	[ ]	[ ]
IV. Physical Chemistry	[ ]	[ ]
Total	100	100

C

Your Field of Specialization in Chemistry

Now please go back to the detailed specifications for the test and select, from the four main categories (Analytical Chemistry, Inorganic Chemistry, Organic Chemistry, and Physical Chemistry), the one which most closely matches your field of special interest.

Under the heading you select from among the four, examine the subheadings A, B, C, etc. For each of these, indicate beside it the percentage of questions you feel should be included in the test to reflect an "ideal" undergraduate preparation for graduate study. The percentages assigned to the A, B, C, etc. categories should total 100.

Next, within each A, B, C, etc. subheading, examine the topics labeled 1, 2, 3, etc. Again indicate the percentage you recommend next to the number of the topic, to reflect an "ideal" undergraduate preparation for graduate study. The percentages assigned to the topics 1, 2, 3, etc. should total 100 within each A, B, C, etc. subheading.

Thus, in schematic form, when you finish assigning percentages, the test outline should appear thus:

Your Field of Special Interest

60% A. Subheading

20% 1. Topic
40% 2. Topic
40% 3. Topic

40% B. Subheading

30% 1. Topic
50% 2. Topic
20% 3. Topic

.
.
.

Classification of Questions into Content Categories

GRE Advanced Test in Chemistry

Enclosed you will find a current copy of the GRE Advanced Test in Chemistry. A subset of the questions has been indicated which fall into your field of specialization. Please read each of the marked questions and classify it into one of the subheadings (A, B, C, etc.) and topics (1, 2, 3, etc.) listed in your field of interest. Write the letter and number of the subheading and topic next to the question on the test form itself. If the question seems to relate to more than one subheading and topic, list those that apply.

When you finish with the set of questions in your field, you may go on to classify as many of the remaining questions as you wish.

The test materials should be treated as confidential and should be kept in a secure place. Please return them promptly when you have finished with them, using the enclosed postage-paid envelope.

MEMORANDUM FOR: TEST FILES, D-420

SUBJECT: Request for Outside Loan FROM: Philip K. Oltman

PLEASE SEND TO: DATE:

THE FOLLOWING TESTS:

Program	Name of Test	Form	Project and Job
GRE	Computer Science	3DGR	546-78

CHECK ONE:

Registered: -----

Certified: X

THE PERIOD OF LOAN IS:

COMMITTEE COPY: _____ (Please indicate EXACT date material is to be returned.)

REGULAR OUTSIDE LOAN (Please check one):

X 30 days (inspection copy within United States or Canada)

_____ 90 days (inspection copy outside United States or Canada)

_____ 6 months (for use of Test Construction Committee)

_____ Permanent (official copy for contractor)

_____ Other - Please specify _____

SIGNED Philip K. Oltman

If the above signature is not on Test Files' authorized list, this request cannot be filled until it is approved and signed by the Program Director whose test is to be lent.

45 _____

PROGRAM DIRECTOR

EDUCATIONAL TESTING SERVICE PRINCETON, N.J. 08541

609-921-9000
CABLE-EDUCTESTSVC

DIVISION OF EDUCATIONAL
RESEARCH AND EVALUATION

Professor Joyce Doe
Department of Computer Science
New Jersey University
Princeton, New Jersey 0854!

Dear Professor Doe:

You are being asked to participate in a content representativeness study of the Graduate Record Examinations Advanced Computer Science Test. Completing the enclosed questionnaires should require no more than a half hour of your time. If you wish to spend more time in examining the test and recording your reactions to it at greater length than the questionnaires permit, we would be happy to have you do so.

In case you were not the recipient of the letter that was originally sent to your department, here is an excerpt from the part of the letter that describes the study.

> As part of a continuing effort to ensure that the Advanced Tests of the Graduate Record Examination (GRE) reflect what is currently being taught at colleges and universities, the GRE Board, which oversees the testing program, has authorized a study of the content representativeness of the GRE Advanced Tests. The tests are developed under the guidance of a Committee of Examiners who are specialists in various aspects of the fields and who come from undergraduate and graduate faculties representative of different types of institutions and different regions of the United States. Although the members of the committee are rotated on a regular basis, they represent, at any one time, only a limited sample of those actively engaged in the teaching of their fields. This content representativeness study is designed to provide a larger sample of professional judgments about the tests and their relation to curricula at various institutions. The study will attempt specifically to determine to what extent the tests reflect the undergraduate curricula recommended as preparation for graduate study in the various fields and to verify that the questions in recent editions of the tests adequately reflect the content specifications that guide their development.

The three different questionnaires enclosed ask you to do the following:

I. Indicate the material that is covered in your undergraduate Computer Science curriculum.

II. Check of the content classification of a designated set of questions (about 50) from a recent form of the examination.

III. Provide some background information concerning you and your institution.

Because of the confidential nature of the test material included in this packet, we ask that you fill out the questionnaires and return them and the test booklet to us within two weeks of receipt of the materials. Furthermore, we ask that you not make copies of the test and that you not show it to others unless you telephone me to request authorization to do so.

We appreciate your cooperation in this study. If you have any questions, feel free to call me collect at the number shown.

Sincerely,

Philip K. Oltman

Philip K. Oltman, Ph.D.
Division of Educational Research
and Evaluation
609/921-9000

GRE Advanced Tests

On the following pages you will find the content specifications which are intended to guide the writing of questions for the test in your field. Please read over the detailed outline and, if you wish, indicate which topics you feel should be eliminated from the test by making an X through the letter or number next to the topic. Space is also provided if you wish to suggest additional topics under the various headings which you feel should be included but which are not presently listed.

Feel free to concentrate your review of the detailed specifications on those areas in which you have major interests.

Detailed Specifications

GRE Advanced Test in Computer Science

I. Software Systems and Methodology

A. Data organization

1. Abstract data types (e.g., stacks, queues, lists, strings, trees, sets)
2. Implementations of data types (e.g., pointers, hashing, encoding, packing, address arithmetic)
3. File organization (e.g., sequential, indexed, multilevel)
4. Data models (e.g., hierarchical, relational, network)
5. Additional _____

B. Organization of program control

1. Iteration and recursion
2. Functions, procedures, and exception handlers
3. Concurrent processes, interprocess communication, and synchronization
4. Additional _____

C. Programming languages and notation

1. Applicative versus procedural languages
2. Control and data structure
3. Scope, extent, and binding
4. Parameter passing
5. Expression evaluation
6. Additional _____

D. Design and development

1. Program specification
2. Development methodologies
3. Development tools
4. Additional _____

E. Systems

1. Examples (e.g., compilers, operating systems)
2. Performance models
3. Resource management (e.g., scheduling, storage allocation)
4. Protection and security
5. Additional _____

II. Computer Organization and Architecture

A. Logic design

1. Implementation of combinational and sequential circuits
2. Functional properties of digital integrated circuits
3. Additional _____

B. Processors and control units

1. Instruction sets, register and ALU organization
2. Control sequencing, register transfers, microprogramming, pipelining
3. Additional _____

C. Memories and their hierarchies

1. Speed, capacity, cost
2. Cache, main, secondary storage
3. Virtual memory, paging, segmentation devices
4. Additional _____

D. I/O devices and interfaces

1. Functional characterization, data rate, synchronization
2. Access mechanism, interrupts
3. Additional _____

E. Interconnection

1. Bus and switch structures
2. Network principles and protocols
3. Distributed resources
4. Additional _____

III. Theory

A. Automata and language theory

1. Regular languages (e.g., finite automata, nondeterministic finite automata, regular expressions)
2. Context-free languages (e.g., notations for grammars, properties such as emptiness, ambiguity)
3. Special classes of context-free grammars (e.g., LL, LR, precedence)
4. Turing machines and decidability
5. Processors for formal languages, (e.g., parsers, parser generators)
6. Additional _____

B. Correctness of programs

1. Formal specifications and assertions (e.g., pre- and post-assertions, loop invariants, invariant relations of a data structure)

2. Verification techniques (e.g., predicate transformers, Hoare axioms)
3. Additional _____

C. Analysis of Algorithms

1. Exact or asymptotic analysis of the best, worst, or average case of the time and space complexity of specific algorithms
2. Upper and lower bounds on the complexity of specific problems
3. NP - completeness
4. Additional _____

IV. Computational mathematics

A. Discrete structures: Basic elements of

1. Abstract algebra
2. Mathematical logic, including Boolean algebra
3. Combinatorics
4. Graph theory
5. Set theory
6. Discrete probability
7. Recurrence relations
8. Additional _____

B. Numerical mathematics

1. Computer arithmetic
2. Classical numerical algorithms
3. Linear algebra
4. Additional _____

V. Special topics

A. Modeling and simulation
B. Information retrieval
C. Artificial intelligence
D. Computer graphics
E. Data communications
F. Additional _____

Content Representativeness of the GRE Advanced Tests

The previous pages provided a detailed description of the content categories currently included in the GRE Advanced Test in your field. On the next page, the main category headings from that outline are listed. Please read through the list and then make two judgments:

1. On a test consisting of 100 questions, how many questions should be devoted to each of the main content categories if the test were to properly represent the undergraduate curriculum for graduate-school-bound students in your discipline as it currently exists at your institution?
2. On a test consisting of 100 questions, how many questions should be devoted to each of the main content categories if the test were to properly represent an "ideal" undergraduate preparation for graduate study to your discipline? [These may or may not differ from the numbers assigned in 1.]

Note that the number of questions should add to 100 for each type of judgment.

Number of Questions in Each Content Category

GRE Advanced Test in Computer Science

Content Categories	Please Fill in Numbers of Questions to Reflect Your Current Undergraduate Curriculum for Graduate-School-bound Students	Please Fill in Numbers of Questions to Reflect an "Ideal" Preparation for Graduate Study
I. Software Systems and Methodology	[ ]	[ ]
II. Computer Organization and Architecture	[ ]	[ ]
III. Theory	[ ]	[ ]
IV. Computational Mathematics	[ ]	[ ]
V. Special Topics	[ ]	[ ]
Total	100	100

E, CS

Classification of Questions into Content Categories

GRE Advanced Tests

Attached to this cover sheet you will find a current copy of the GRE Advanced Test in your field. A subset of the questions has been indicated for your response; please read each of the indicated questions and classify it into one of the main content categories listed on the form on which you assigned percentages of recommended coverage (i.e., I, II, etc.). Write the Roman numeral of the main category next to the question on the test form itself. If the question seems to relate to more than one category, list those that apply.

When you finish with the set of indicated questions, you may go on to classify as many of the remaining questions as you wish.

The test materials should be treated as confidential and should be kept in a secure place. Please return them promptly when you have finished with them, using the enclosed postage-paid envelope.

E

MEMORANDUM FOR: TEST FILES, D-420

SUBJECT: Request for Outside Loan

FROM: Philip K. Oltman

PLEASE SEND TO:

DATE:

THE FOLLOWING TESTS:

Program	Name of Test	Form	Project and Job
GRE	Education	3DGR	546-78

CHECK ONE:

Registered: -----

Certified: X

THE PERIOD OF LOAN IS:

COMMITTEE COPY:_____(Please indicate EXACT date material is to be returned.)

REGULAR OUTSIDE LOAN (Please check one):

X 30 days (inspection copy within United States or Canada)

_____ 90 days (inspection copy outside United States or Canada)

_____ 6 months (for use of Test Construction Committee)

_____ Permanent (official copy for contractor)

_____ Other - Please specify_____

SIGNED Philip K. Oltman

If the above signature is not on Test Files' authorized list, this request cannot be filled until it is approved and signed by the Program Director whose test is to be lent.

55 PROGRAM DIRECTOR

EDUCATIONAL TESTING SERVICE PRINCETON, N.J. 08541

609-921-9000
CABLE-EDUCTESTSVC

DIVISION OF EDUCATIONAL
RESEARCH AND EVALUATION

Professor Joyce Doe
Department of Education
New Jersey University
Princeton, New Jersey 08541

Dear Professor Doe:

You are being asked to participate in a content representativeness study of the Graduate Record Examinations Advanced Education Test. Completing the enclosed questionnaires should require no more than a half hour of your time. If you wish to spend more time in examining the test and recording your reactions to it at greater length than the questionnaires permit, we would be happy to have you do so.

In case you were not the recipient of the letter that was originally sent to your department, here is an excerpt from the part of the letter that describes the study.

> As part of a continuing effort to ensure that the Advanced Tests of the Graduate Record Examination (GRE) reflect what is currently being taught at colleges and universities, the GRE Board, which oversees the testing program, has authorized a study of the content representativeness of the GRE Advanced Tests. The tests are developed under the guidance of a Committee of Examiners who are specialists in various aspects of the fields and who come from undergraduate and graduate faculties representative of different types of institutions and different regions of the United States. Although the members of the committee are rotated on a regular basis, they represent, at any one time, only a limited sample of those actively engaged in the teaching of their fields. This content representativeness study is designed to provide a larger sample of professional judgments about the tests and their relation to curricula at various institutions. The study will attempt specifically to determine to what extent the tests reflect the undergraduate curricula recommended as preparation for graduate study in the various fields and to verify that the questions in recent editions of the tests adequately reflect the content specifications that guide their development.

The three different questionnaires enclosed ask you to do the following:

I. Indicate the material that is covered in your undergraduate Education curriculum.

II. Check of the content classification of a designated set of questions (about 50) from a recent form of the examination.

III. Provide some background information concerning you and your institution.

Because of the confidential nature of the test material included in this packet, we ask that you fill out the questionnaires and return them and the test booklet to us within two weeks of receipt of the materials. Furthermore, we ask that you not make copies of the test and that you not show it to others unless you telephone me to request authorization to do so.

We appreciate your cooperation in this study. If you have any questions, feel free to call me collect at the number shown.

Sincerely,

Philip K. Oltman

Philip K. Oltman, Ph.D.
Division of Educational Research
and Evaluation
609/921-9000

BACKGROUND INFORMATION QUESTIONNAIRE

GRE CONTENT REPRESENTATIVENESS STUDY

1. Name _____

2. Academic rank (e.g., Associate Professor) _____

3. Administrative responsibilities, if any (e.g., Department Chair, Graduate Administrator) _____

4. Official name of your department _____

5. Institution _____

6. Your speciality or area of primary interest. Make up to three entries in order of importance.

   1. _____

   2. _____

   3. _____

7. Years of teaching experience at the college level. _____

8. Year in which you received your highest earned degree. _____

9. Your average teaching load (number of contact hours per week) during the past five years (or since you started teaching if you have been teaching fewer than five years). _____

10. Approximate number of doctoral dissertations you have directed during the past five years, if any. _____

11. Approximate number of masters theses directed during the past five years, if any. _____

GRE Advanced Tests

On the following pages you will find the content specifications which are intended to guide the writing of questions for the test in your field. Please read over the detailed outline and, if you wish, indicate which topics you feel should be eliminated from the test by making an X through the letter or number next to the topic. Space is also provided if you wish to suggest additional topics under the various headings which you feel should be included but which are not presently listed.

Feel free to concentrate your review of the detailed specifications on those areas in which you have major interests.

Detailed Specifications

GRE Advanced Test in Education

I. Educational Goals

A. History-Philosophy: Aims of Education as related to

1. Historical and philosophical periods, including Renaissance, Colonial America, Scientific Revolution, etc.
2. Leading historical and philosophical figures, including Plato, Aristotle, Rousseau, Froebel, Horace Mann, Dewey, etc.
3. Positions and systems of education, including aristocratic, totalitarian, democratic-pluralistic, pragmatist, idealist, realist, etc.
4. Philosophical concerns, including intellectual elite, universal education, values and the teaching of values, vocational education, individual vs. society, etc.
5. Ways of stating educational goals, including behavioral and nonbehavioral objectives
6. Additional _____

B. Psychology: Aims of Education in Relation to the Development of the Child

1. Physical development and psychomotor learning, including health and physical fitness, etc.
2. Emotional-social development and learning, including mental health, social skills, etc.
3. Intellectual development, including opportunity to develop cognitive abilities, etc.
4. Individual differences
5. Additional _____

C. Social Sciences: Role of Education as Related to

1. Community and regional goals and aims
2. A pluralistic society, including multicultural groups
3. Various social and political systems, including democracy, totalitarian, etc.
4. International awareness and cooperation
5. Additional _____

V. Administration and Supervision of the Schools

A. History-Philosophy: Development and Justification of Sources of Influence and Authority

1. Roles of national, state, local, and private agencies, including U.S. Constitution, Supreme Court, Office of Education, county and local school district, state legislatures, accrediting agencies, foundations, etc.
2. Types of organizational units, including the middle school, junior high school, high school, 6-6 and 6-4-4 plans, etc.
3. Authority as related to philosophical considerations, including locus and justification of authority; nature of authority, responsibility, and accountability; etc.
4. Ethical rights and responsibilities of teachers, including professional organizations, unions, responsibility to students, etc.
5. Additional _____

B. Psychology: Psychological Considerations in Regard to the Administration and Supervision of the Schools

1. Relationship of grouping of students to efficiency in learning, including non-graded classroom, self-contained classroom, homogeneous grouping, etc.
2. Relationship of staff organization to teacher and student morale and efficiency, including group dynamics, assignment, teaching load, etc.
3. Other factors affecting morale, mental health, and efficiency of teachers and students, including personnel policy, physical facilities, etc.
4. Additional _____

C. Social Sciences: Considerations Related to the Administration and Supervision of the Schools

1. Teachers and their legal rights and responsibilities
2. Students and their legal rights and responsibilities
3. Community characteristics, needs, aspirations, and roles in educational planning and policy making
4. The role of the school in the social order, including relation of school to church, home, etc.; impact of social forces upon school organization; etc.
5. The economy and education, including taxation, impact of the closing of schools upon the labor market, etc.
6. Politics and education, including controversial topics in the curriculum, the influence of political forces on educational policy, etc.
7. Additional _____

III. Curriculum Development and Organization

A. History-Philosophy: The Evolution and Justification of the Curriculum in the Schools

1. Historical influences upon the curriculum, including evolution of the curriculum, work of special curriculum committees, special interest groups, etc.
2. Characteristics of various types of curriculum organization, including broad fields, core, basic education, etc.
3. Curriculum and problems of knowledge, including structure of the disciplines, etc.
4. Curriculum theories and patterns of organization as related to values, including individual values, political aims, etc.
5. Additional _____

B. Psychology: Curriculum and Its Relationship to Psychological Concerns

1. Curriculum as related to human development, including physical growth, cognitive and moral development, etc.
2. Curriculum as related to learning factors, including motivation, readiness, etc.
3. Additional _____

C. Social Sciences: Curriculum Considerations

1. Curriculum as influenced by demands on education, including social class, family, vocational needs, multicultural dimension, metric movement, etc.
2. Curriculum as related to other societal considerations, including media, unemployment, crime and violence, etc.
3. Additional _____

IV. Teaching-Learning

A. History-Philosophy: The Evolution and Conceptualization of Teaching-Learning

1. Theories of teaching-learning in philosophic systems as they relate to the works of individual philosophers or exemplars
2. Teaching-learning as related to curriculum type, including classical literature, science and mathematics, vocational education, etc.
3. Teaching-learning as related to teaching method, including individualized instruction, the Socratic method, programmed instruction, open education, etc.
4. Logical aspects, including defining, inferring students' thoughts, explaining, questioning, evaluating claims, etc.
5. Concepts of teaching-learning, including indoctrination, teaching, learning, neutrality, etc.
6. Additional _____

B. Psychology: Psychological Considerations in Regard to Teaching-Learning

1. The nature of the learner

   a. Intellectual development, including the nature and measurement of intelligence, biological and cultural influences on intellectual functioning as measured, individual differences, etc.
   b. Social and emotional development, including the nature of the socialization process and related influences upon its development, personality and adjustment, etc.
   c. Physical development, including patterns of physical growth, factors affecting physical growth, etc.

2. The teaching-learning process

   a. Kinds of learning, including cognitive, affective and psychomotor learning, intellectual skills, communication skills, etc.
   b. Basic concepts and principles related to learning, including reinforcement, motivation, extinction, shaping, discrimination, transfer, operant and classical conditioning, etc.
   c. The guidance of learning in the classroom, including characteristics of teachers and their influence on learning, classroom management techniques (e.g., climate for learning, group dynamics, etc.), application of learning concepts and principles to specific instructional problems, specific instructional techniques and media (e.g., discovery learning, programmed instruction, etc.), the teacher as a communicator, etc.
   d. Models of teaching-learning, including behavioristic, cognitive-developmental, humanistic, social interaction, etc.

3. Additional _____

C. Social Sciences: Considerations in Regard to Teaching-Learning

1. Influence of social class stratification on teaching and learning
2. Styles of teaching and patterns of social control, including authoritarian controls, democratic controls, etc.
3. Teacher's role as a member of a social system, including school faculty, profession, community, etc.
4. Impact of cultural background on learning
5. Additional _____

V. Measurement, Evaluation, and Research

A. History-Philosophy: The Evolution and Methodology of Research and Measurement in Education

1. Development of scientific method and measurement, including key figures in application of method to study of education and the behavioral/social sciences
2. Research methodology, including understanding of scientific method, specific techniques and types of studies, documentation, reliability of sources, statistical and practical significance, etc.
3. Analysis of crucial concepts related to testing and measurement, including such concepts as aptitude, intelligence, cultural bias, operational definitions, construct validity, etc.
4. Ethical issues in educational research, such as invasion of privacy, informed consent, risk, etc.
5. Additional _____

B. Psychology: The Assessment of Pupil Growth

1. Basic concepts in measurement and statistics, including measures of central tendency, measures of dispersion, validity, reliability, types of test scores (e.g., percentiles, standard, etc.), etc.
2. Assessment methods, including the use of standardized and teacher-made tests, criterion and norm-referenced tests, characteristics of various types of test questions, informal types of assessment such as case study and observation, etc.
3. Measurement of personal-social adjustment and affective outcomes, such as sociometric techniques, rating scales, checklists, etc.
4. Additional _____

C. Social Sciences: Practices, Trends, and Issues with Regard to

1. Evaluating and reporting of pupil growth and progress, including role of evaluation in instruction, methods of reporting to parents, etc.
2. Use and implications of standardized testing with diverse groups within society
3. Collection, maintenance, and use of pupil records and data, including rights of privacy, dissemination procedures, etc.
4. Evaluation of educational programs, including teacher accountability, evaluation of curriculum and instructional resources, cost benefit analysis, etc.
5. Additional _____

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Number of Questions in Each Content Category

GRE Advanced Test in Education

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I. Educational Goals	[ ]	[ ]
II. Administration and Supervision of the Schools	[ ]	[ ]
III. Curriculum Development and Organization	[ ]	[ ]
IV. Teaching-Learning	[ ]	[ ]
V. Measurement, Evaluation, and Research	[ ]	[ ]
Total	100	100

E, CS

Classification of Questions into Content Categories

GRE Advanced Tests

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Appendix D

Chemistry

Detailed Allocations to Specifications and Items

I. Analytical Chemistry

A. Classical quantitative area

Specs[1]	Items[2]		
32.6	45.6	1.	Titrimetry
29.2	26.8	2.	Separations, including theory and applications of chromatography as well as gravimetry
14.0	5.9	3.	Data handling, including statistical tests (t, F, Q, chi-square)
15.8	13.2	4.	Standards and standardization techniques
8.3	8.4	5.	Additional _____

B. Instrumentation area

13.4	0.7	1.	Basic electronics
32.7	35.7	2.	Electrochemical methods
43.8	61.3	3.	Spectroscopic methods, including mass spectroscopy and those in the electromagnetic spectrum from high-energy nuclear processes of radioactivity to nuclear magnetic resonance
10.0	2.2	4.	Additional _____

II. Inorganic Chemistry

A. Atomic theory

19.5	30.0	1.	Elementary particles
56.0	57.0	2.	Atomic structure
20.5	13.0	3.	Classical experiments
4.0	0.0	4.	Additional _____

B. The nucleus

27.0	7.3	1.	Binding energy
26.0	31.6	2.	Abundance and stability of nuclei
37.0	55.6	3.	Isotopes
9.0	5.6	4.	Additional _____

C. Extranuclear structures and related properties

25.1	21.1	1.	Electronic distributions in atoms
30.1	13.5	2.	Periodic classifications
31.9	48.6	3.	Properties dependent on extranuclear structure
12.7	16.5	4.	Additional _____

[1]Mean percents of items respondents recommended for each category.

[2]Mean percents of items respondents classified in each category.

D. Chemistry of the families of elements

Specs	Items		
45.9	66.0	1.	Preparations, reactions, properties, and important applications of the elements and their compounds stressing family relationships and dependence on extranuclear structure
37.3	20.4	2.	Families of representative elements, families of transition elements, lanthanides and actinides
16.8	13.6	3.	Additional _____

III. Organic Chemistry

A. Principal reactions of simple functional groups

11.2	13.5	1.	Hydrocarbons
11.4	6.7	2.	Alcohols
9.2	12.1	3.	Alkyl and aryl halides
7.6	5.6	4.	Organometallic compounds
15.8	30.6	5.	Carbonyl compounds
5.9	2.5	6.	Conjugate unsaturated carbonyl compounds
9.6	3.5	7.	Amines
5.1	7.2	8.	Diazonium compounds
10.7	10.9	9.	Acids
5.7	0.9	10.	Phenols
4.8	1.5	11.	Simple sulfur-containing compounds
3.2	2.6	12.	Additional _____

B. Structure and mechanism

14.5	10.5	1.	Electronic structures
21.2	16.0	2.	Isomers and stereochemistry
15.8	26.8	3.	Theoretical concepts
24.3	35.3	4.	Basic reaction mechanisms
19.3	10.1	5.	Structural interpretation of spectral (ultraviolet, infrared, nuclear magnetic resonance) data
4.9	1.4	6.	Additional _____

C. More advanced topics and special topics

11.2	8.0	1.	Laboratory topics
10.9	29.1	2.	Classical reaction types
8.5	0.2	3.	Classical rearrangements
11.4	2.0	4.	Differentiations by chemical tests
6.4	9.9	5.	Special reagents
8.5	7.0	6.	Bifunctional compounds
10.6	0.2	7.	Polymerizations
8.3	5.5	8.	Natural products
9.7	21.1	9.	Comparisons of reactivity
8.7	10.7	10.	Biochemically-related topics
5.9	2.7	11.	Additional _____

IV. Physical Chemistry

A. Classical and statistical thermodynamics

Specs	Items		
11.3	4.2	1.	Equations of state
22.1	21.4	2.	First, second, and third laws
25.0	40.6	3.	E(U), H, S, G, μ, C_p, C_v, phase equilibria
18.6	12.7	4.	Equilibrium conditions
7.1	0.0	5.	Nernst's equation
15.4	20.1	6.	Elementary statistical mechanics
0.6	1.3	7.	Additional _____

B. Quantum chemistry and spectroscopy

48.0	67.2	1.	Energy levels and wave functions for atomic and molecular electrons, harmonic oscillators, rigid rotors, and translational motions
11.6	3.2	2.	Selection rules
35.8	26.1	3.	Microwave, infrared, visible, Raman, and nuclear magnetic resonance spectroscopy
4.6	3.6	4.	Additional _____

C. Kinetics and other topics

14.8	12.9	1.	Elementary kinetic theory of gases
22.5	43.3	2.	Rate laws and mechanisms
6.6	10.8	3.	Crystallography
5.6	0.4	4.	Dielectric properties
14.5	3.8	5.	Electrochemistry
7.3	6.2	6.	Surface chemistry
6.9	0.0	7.	Polymers
15.9	22.4	8.	Chemistry of solutions
3.8	0.0	9.	Applications to biological systems
2.3	0.3	10.	Additional _____

Appendix E

A Procedural Manual for Conducting Content Representativeness Studies

Philip K. Oltman

Research Psychologist

Division of Educational Research and Evaluation

Supplement to GRE No. 81-12P

August 6, 1982

Sample

The sample for a given discipline can be drawn from the data base contained in the Higher Education General Information Survey tapes (HEGIS). These tapes are available in the Measurement, Statistics, and Data Analysis Research Division (contact Norma Norris). The program for generating the sample is on file in that division and is described in Appendix F.

The HEGIS survey divides the United States into eight geographical regions, and the program selects institutions to represent each region approximately equally. For each region, the tape is searched for all institutions offering a degree in the particular discipline of interest. Within that list for each discipline, institutions are selected randomly, subject to the following constraints:

1. Approximately 50% public and 50% private control.

2. Approximately 75% with more than 10,000 total enrollment and 25% with between 1,000 and 9,999 enrollment.

3. Approximately 50% offering a doctoral degree in the discipline and 50% offering up to but not including a doctoral degree.

These criteria for selection can be easily modified if desired. In the study described in GRE Report No. 81-12P, we aimed for 8 to 10 institutions per region, and since not every region contained each type of institution, the percentages listed above are approximate.

The resulting sample of institutions is randomly selected for each discipline, subject only to the above stated constraints. While it is not a strictly stratified sample, it does appear to yield a generally representative group of institutions and does not depend upon human judgment other than in setting the constraints. A more detailed description of the procedure is presented in Appendix F. The samples used in the present study are presented in Appendix A.

Chair Letters

Using the list of institutions generated from the HEGIS tapes, a letter inviting participation in the study is addressed to the chairperson of the department at each. In GRE Report No. 81-12P, the addresses were from college directories. The text of the chair letter is presented in Appendix B, and is available on Vydec disk. Addressing the letters and envelopes can be done by Vydec, or by means of copying machine or computer-generated labels.

The letters themselves could be Vydec originals, or printed on ETS letterhead, as was done in GRE 81-12P. When more than one discipline is being studied concurrently, it is advisable to have a code appear in one corner of each page, so that the material can be quickly and accurately identified without searching the text each time.

Telephone follow-up of each letter is an option and would probably increase response rates. It is costly, however, both in toll charges and in personnel time, since chairpersons are almost never at their desks. Several calls and messages are usually necessary to speak to the chairperson. In GRE 81-12P, we initially elected to call when we received no response to the departmental mailing and to a follow-up mailing. These calls did not seem to be worth the added expense, however, and were not continued after the first several dozen. We have concluded that response rates can be adequate without telephone follow-up, but this decision can be made by the study director.

Respondent Letters

The text of the respondent letter is presented in Appendix C. This letter is mailed to each individua' designated by the department chair to participate in the study. We requested two names per department, and were usually furnished that number, although in a few cases three or more faculty members agreed to participate.

In GRE 81-12P, the respondent letters were preprinted on ETS letterhead paper. Each name and address was typed on a bond paper sheet and used to generate labels using copying machine label sheets. We produced several identical sets of labels so that we could address the respondent letter, affix another label to the Test Files Order Form (see below) and another to the test itself. In this way all materials received from a respondent were clearly labelled. Each label had a code in the lower right-hand corner that identified the discipline and the geographical region, to facilitate sorting and filing (e.g., the label for a chemistry faculty member in the third region would be coded C3 in the lower-right corner).

Materials Mailed to Respondents

The set of materials mailed to each of the three disciplines are shown in Appendix C. They consist of the following items:

Test Files Order Form. All mailing and receipt of materials is done through Test Files. Test Files is supplied with the Order Form and a set of materials for respondents. They then add a copy of the test form being examined and mail the material to the respondents by certified mail with a return receipt requested. The standard procedures of Test Files are followed, with the exception that the study materials are inserted in the envelope along with the test form. Respondents mail materials back to Test Files, where they are picked up for processing.

The Test Files Order Forms are preprinted with a code in the upper-left corner to indicate the discipline, along with additional information including the program, name of test, form, P/J, etc. Test Files personnel affix a respondent label to each test as it is sent out. The Test Files Order Form is followed by:

1. Respondent Letter. This letter is on Vydec disk. A respondent label is attached to each letter.

2. Background Information Questionnaire. This form is on Vydec disk and can easily be edited to meet particular requirements. It asks respondents to supply several items of descriptive information so the sample can be described more fully.

3. Introduction to the Specifications. Describes the specifications and requests respondents to review them.

4. Detailed Specifications. The level of detail of the working specifications varies with the discipline. The fineness of detail of the outline presented to respondents should be decided with the advice of the ETS test specialist. We included finer levels of detail than were allocated by respondents as a way of explicating the meaning of the higher level categories.

5. Introduction to the Specification Distribution. This introduction requests respondents to recommend how much of the test should fall into the main content categories of the specifications, both to represent their current curriculum and an ideal graduate-school-preparation curriculum. The main categories should number no more than about eight for this task. If this high a level of generality would be uninformative, additional judgments can be obtained (see chemistry, below).

6. Specification Distribution Sheet. The layout should lend itself to encoding the data for later analysis.

7. Special Specification Distribution. A more detailed specification distribution judgment may be included when the main categories are not sufficiently informative. For example, in GRE 81-12P, the main categories dividing the domain of chemistry were too general to be of much value. Therefore, respondents were asked to distribute percentages of coverage within their field of specialization. Fields were identified in advance from a professional directory. Percentages were assigned both at the subheading level (A, B, C...) and at the topic level within subheadings (1, 2, 3...). See Appendix C for more detail. A page of instructions for this task

was included; respondents indicated their percentage assignments on the specifications themselves. (Specifications should be printed so this is possible.)

8. Introduction to Item Classification. Respondents are asked to classify a subset of the test items into the categories of the specifications. Classification of an item into more than one category is allowed. In GRE 81-12P, respondents were asked to classify no more than 50 items. For disciplines for which main category classification was satisfactory, the tests were spiraled so that each succeeding respondent classified a different subset of items. The tests were premarked with labels to indicate which set of items should be classified.

   In GRE 81-12P, the item classification task for chemistry was done within fields of specialization, rather than by arbitrary subsets of items. Each respondent received a test with item numbers circled in red to correspond to his or her specialty in chemistry. The respondent then classified the items by subheading (A, B, C...) and, within subheading, by topic (1, 2, 3...).

9. Test Form. The form to be used should be selected by the test specialist. In GRE 81-12P, it was a current form (3DGR).

Mailing Procedure

Test Files should be contacted well in advance of the study so that a sufficient supply of the form to be used can be on hand. These forms should be premarked with the item set to be classified and kept in a separate storage area in Test Files. If tests are to be premarked in specialty areas, as was done for chemistry, it may be more convenient for the supply of tests to be kept by the test specialist and items marked as needed for mailing.

Letters to the department chairpersons are mailed out next, with preaddressed postage-paid return envelopes enclosed. A return form may also be enclosed for the chairperson to indicate names of participants or to indicate that they decline to participate. Such a form might increase response rate, although it was not used in the present study. Return mailings from departments should be logged in on a master roster of departments organized by region. Such an organization by region facilitates location of an institution and highlights regions that are slow to respond.

As returns from departments arrive, the names and mailing addresses of respondents are typed onto respondent rosters. For the present study, these were typed using a template to achieve proper spacing for running

off copying machine labels. As pages of the roster were completed (21 names and addresses per page in this study), the labels were run off and sets of materials were assembled.

Items 1 through 8 on the above list of materials mailed to respondents were stapled together (i.e., all material except the Test Files Order Form and the test itself; see Figure 1). If possible, these materials could all be printed, collated, and stapled by the Printing Department rather than being assembled later.

After assembling the materials and affixing the respondent labels to the Test Files Order Form and the respondent letter, the Order Form and materials packet are clipped together. The set of material is then taken to Test Files, along with a sheet of labels for Test Files personnel to affix to the tests. Mailing and receipt is then handled by Test Files.

As respondents return their materials to Test Files, the materials can be picked up and brought to the project office for coding.

A secure storage cabinet should be available for maintaining the files, since they include the current test forms. When all information has been coded from the test forms, they can be sent to Confidential Scrap for shredding.

Coding the Data for Analysis

The data should be coded from the materials into keypunchable format. Even if it is decided to do the analyses by hand, this type of coding is neat, orderly, and convenient. If hand analysis proves too time-consuming, cards can readily be punched and the analyses run on the computer. Standard statistical packages (BMDP, SPSS) can readily compute most of what is needed.

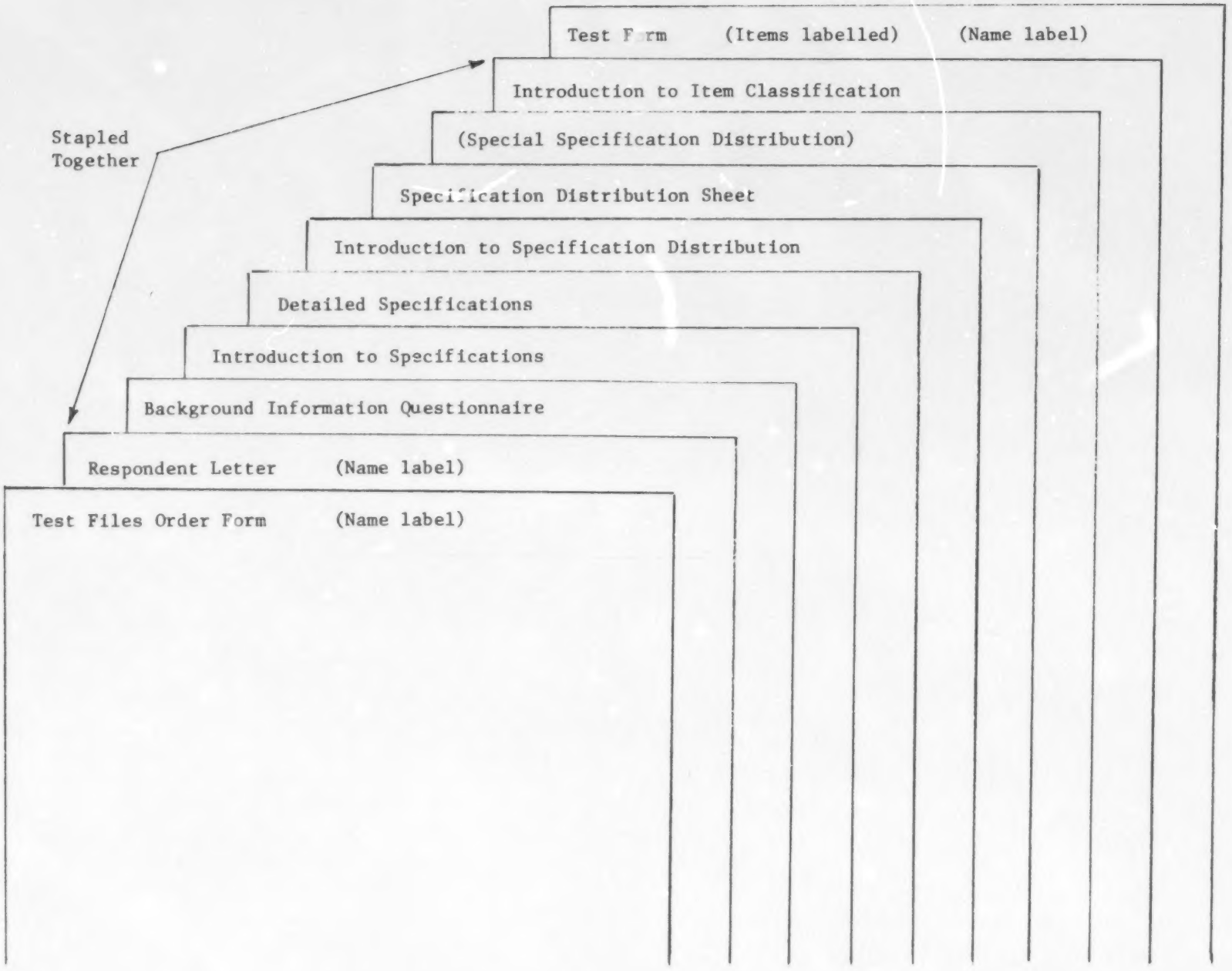
1. Respondent Identification. In GRE 81-12P, respondents were identified by a code consisting of the first letter(s) of the discipline name, the number corresponding to the geographical region, and the first five letters of the respondent's last name (e.g., a chemist from the fourth region named Gordon would be coded C4GORDO).

2. Institution Characteristics. Public vs. private, up to doctorate vs. doctorate, and small vs. large can be coded 1 or 2 respectively. This information is printed for each institution in the output of the sampling program.

3. Item Set. A code is entered to indicate the set of items the respondent classified (e.g., for a 200-item test, with sets of 50 items, codes could be 1, 2, 3, and 4).

4. Background Information Questionnaire. In GRE 81-12P, the following items were coded as indicated:

Figure 1
Assembly of Materials



Academic rank: 1 = Professor, 2 = Associate Professor, 3 = Assistant Professor, 4 = other

Administrative responsibilities: 1 = any administrative responsibilities, 2 = none indicated

Years teaching: The number given

Year of highest degree: The last two digits of the year given

Average teaching load: The hours given

Number of doctoral dissertations directed: The number given

Number of master's theses directed: The number given

The indicated areas of specialization were not coded for quantitative analysis. They can be recorded and categorized to help describe the sample.

5. Specification Distribution Sheet. The percentages assigned are coded in each category. Leave sufficient room on the data sheet to record 100 in the unlikely event that a respondent assigns all content to one category.

Check that percentages assigned add to 100. If they do not, usually because of a computational error by the respondent, then add the entries, and divide each by the sum to convert to a 0 to 100 scale. Then record the converted values.

(5a). Special Specification Distribution. If this detailed breakdown is included, it is coded at two levels. First, the A, B, C... levels are recorded; the entries should total 100. Then, within each of those subheadings, the topics labelled 1, 2, 3... are recorded; those should each total 100 within subheadings.

6. Item Classification. These data are taken from the test form, on which respondents have indicated beside each item the specification category or categories to which they judged it to belong. The classification(s) of each item is entered on an intermediate form with columns labelled with the Roman numerals (or subheadings and topics for detailed classification) corresponding to each category. After these are entered, they are totalled for each category and converted to percentages by adding the total number of classifications and dividing each category entry by that total. Thus, if an item were classified into two different categories, it would be counted once in each category. If a respondent sorted 50 items, using only single categorization, the total of the entries would be 50; if multiple categorizations were used, the total of the entries would exceed 50. In any case, percentages are arrived at by dividing the entries in each category by the total number of entries.

Note that the above method will reflect the distribution of categorizations made by the respondent but will not preserve the categorizations

of individual items. If agreement on individual items is to be assessed, an items vs. categories matrix must be constructed for each respondent. In GRE 81-12P, individual item agreements were not coded, since the focus was on the distribution of content that each respondent saw in the items.

Appendix F

Memorandum for: PHILIP K. OLTMAN

cc: John Barone
Norma Norris

Subject: Documentation for Hegis Sampling Procedure

Date: September 11, 1981

From: David Freund

The five HEGIS tapes have been copied to standard ETS T-tapes and are cataloged as follows:

NAN6600.HEGIS.OFE11.Y7677 - T33524
NAN6600.HEGIS.ERD12.Y7677 - T37469
NAN6600.HEGIS.OFE13.Y7879 - T29867
NAN6600.HEGIS.ERD14.Y7879 - T37231
NAN6600.HEGIS.ACE. Y7879 - T32240

CREATION OF HEGIS SAMPLE:

There were five major steps and several miscellaneous ones performed in creating the sample. The programs are cataloged under:DSF6600.HEGIS.SAMPLE.FORT.

1. CRDOMAIN - The first step done was copying the records of the disciplines (Cols. 87-89) from which samples were to be drawn to disk, using TAPE.T37231. By copying the records to disk, only one pass through the approximately 160,000 records was necessary.

2. SORTDOM - This program assigns a number from 1 to 64 (writes to Cols. 176, 178) for each discipline based on the following strata:

   8 geographical regions (Col. 24, OBE region) of the U.S. (yield 8-10 schools in each).

   Within each region:

   A) 75% of the schools offer a doctoral program and 25% offer a bachelor's degree up to a doctoral degree (Cols. 32, 33).

   B) 50% of the schools are large (>10,000 students) and 50% are small (1,000 - 10,000) (Col. 39).

   C) 50% are public and 50% are private (Col. 26).

It was determined the best way to fit the strata was as follows:

For any region j, j=1,...,8:

	Small			Large	
	Public	Private		Public	Private
Doctoral	2	1	Doctoral	2	1
Nondoctoral	1	1	Nondoctoral	1	1

3. SAMPACTS - Computes the total N for each cell of the domain.

4. SAMPLE - actually creates the sample. The programming technique is quite simple; for each cell there exists an N as computed in step #3. The program assigns n random integers from 1 to N; n is the desired sample size for a given cell as illustrated above. A counter then matches the random counts with the actual record counts. When a match occurs, the record is put into the sample.

5. LISTSAMP - lists the sample broken down into the various strata.

Note: In some instances, it was not possible to get a sample size of 8-10, because some of the cells within a region had no schools that met the particular criteria for that cell.

Attached is a copy of the program.

```
FORTRAN IV G1  RELEASE 2.0              MAIN              DATE = 81245          08/10/45

0001                  REAL*8 REGION(8)/'REGION 1','REGION 2','REGION 3','REGION 4',
                     +'REGION 5','REGION 6','REGION 7','REGION 8'/,
                     +SCHTYP(2)/'PUBLIC  ','PRIVATE '/, HIGHDE(2)/'BAC-PH.D',
                     +'  PH.D  '/, ENROLL(3)/'1K - 10K','> 10,000'/,
                     +DISP(3,3)/'GENERAL ','CHEMISTR','Y       ','GENERAL ','COMPU'
                     +' SCIENCE','EDUCATIO','N       ',' ','       '/, SCHOOL(4)/4*' '/,
                     +HED(8)/'DISCIPLI','NE IS:  ',3*' ',' -      ',' ','*'/
0002                  REAL REC(45)
0003                  CALL START('HEGIS STUDY: RANDOM SAMPLE OF SCHOOLS THAT FIT DEFINED
                     + STRATA*')
0004                  CALL OPEN(10)
0005                  DO 10 J=1,3
0006                    JREG=1
0007                    CALL MOVSTR(24,1,DISP(1,J),16,HED)
0008                    DO 20 K=1,8
0009                      IOLD=JREG
0010                      CALL MOVSTR(8,1,REGION(K),45,HED)
0011                      IFIRST=1
0012                      CALL NEWPG(HED)
0013                      IF (J.EQ.1 .AND. K.EQ.1 )GO TO 5
0014                      GO TO 50
0015                5     CALL GET(10,REC,&999)
0016                      CALL MOVSTR(24,46,REC,1,SCHOOL)
0017                      JREG=ICOL(24)
0018                      JPUB=ICOL(26)
0019                      JDEG=1
0020                      IF (ICOLS(32,33).EQ.8) JDEG=2
0021                      JK=1
0022                      IF (ICOL(39).GT.6) JK=2
0023                      IF (IOLD.NE.JREG) GO TO 20
0024                      IOLD=JREG
0025                50    IF (IFIRSY.EQ.1) WRITE(6,6000)
                         +            SCHOOL,SCHTYP(JPUB),HIGHDE(JDEG),ENROLL(JK)
0026                      IF (IFIRST.NE.1) WRITE(6,7000)
                         +            SCHOOL,SCHTYP(JPUB),HIGHDE(JDEG),ENROLL(JK)
0027                      IFIRST=2
0028                      GO TO 5
0029                20    CONTINUE
0030                  10 CONTINUE
0031              6000 FORMAT(/,/,1X,4A8,'-  ',A8,'  -  ',A8,'  -  ',A8)
0032              7000 FORMAT(1X,4A8,'-  ',A8,'  -  ',A8,'  -  ',A8)
0033               999 CALL STEXIT
0034                   CALL EXIT
0035                   END
```

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